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Section 5

Southeast Colorado River Basin

Utah State Water Plan

Water Supply and Use

5.1 INTRODUCTION

This section of the Southeast Colorado River Basin Plan discusses the present surface water and groundwater supply available and its present use. Although the Colorado and San Juan rivers could be major water sources, their use is small when compared to local streams and groundwater. The Colorado River is used mostly for recreational activities although there is some water diverted for irrigation. Irrigation water and some municipal and industrial water are diverted from the San Juan River along with recreational uses. In addition, there is some Dolores River water used for irrigation near La Sal.

Projected water uses and demands are discussed in Section 9. Agricultural water uses are discussed further in Section 10 and culinary water is discussed in more detail in Section 11. Groundwater is discussed in more detail in Section 19.

5.2 BACKGROUND

The Southeast Colorado River Basin is bordered on the west by the Colorado River and Green River, on the north by the Book Cliffs and on the south and east by Arizona and Colorado state lines. The drainages that flow north to the Uinta Basin are not included. Although the southern part of the western boundary has been generalized as the Colorado River, the boundary as used in this report is the eastern shore line of Lake Powell. The Uinta Basin hydrologic area is on the north and the West Colorado River Basin is on the west.

Much of the water from the perennial streams originating within the basin have been developed. There is still some undeveloped surface water and a supply of undeveloped groundwater in several aquifers throughout the area. These supplies will be developed as the demand increases and when it becomes economically feasible.

Water is the lifeblood that supports man's endeavors, especially in an otherwise harsh, unfriendly land. Water helps crops grow, quenches mans thirst and enriches the surrounding environment.

Most of the surface water supply diverted for use originates either on the La Sal Mountains or the Abajo Mountains. These mountains also recharge the groundwater that shows up in the valleys in the form of springs or seeps and are the primary supply for the alluvial and consolidated rock aquifers.

Many normally dry drainages experience short-duration flows produced by high-intensity cloudburst storms or unusually high snow-melt runoff. These are not a dependable supply of water although there is some recharge to the alluvial or consolidated rock aquifers.

The primary use of water is for irrigation although use for municipal purposes is increasing, especially in Grand County. Water use for industry is increasing but it is still less than one-fourth of the total use.

The Southeast Colorado River Basin was divided into 17 subareas for purposes of the land-use inventory and preparation of the water budgets. These hydrologic subareas are shown on Figure 5-1. The water budgets are an accounting procedure for determining all the water inflows, supplies, uses and outflows within a given hydrologic subarea. These subareas were delineated to take advantage of hydrologic and geologic conditions that would minimize unknown variables. The base period used for the water budgets and calculating the yield was 1961-90.[12] The land-use surveys were made in 1990.[19] Most of the groundwater data was based on varying periods of records or spot measurements. The municipal and industrial water use is based on data collected during 1996.[14]

5.3 WATER SUPPLY

The total water supply comes from precipitation, mostly in the higher elevations. Up to 90 percent of the precipitation in the upper watersheds is consumed by native vegetation and evaporation. This need must be met before there is surface water runoff or infiltration to the groundwater aquifers that feed springs and provide groundwater inflow. Because of this relationship, a small change in precipitation can cause a large change in water yield.

Water has been and still is a scarce resource in this area. One of the first things the early settlers did was to dig ditches and divert water onto the land so they could grow crops. When the first Mormon settlers established the Elk Mountain Mission in 1855 at present Moab, they first diverted water to vineyards and orchards. These were abandoned when the settlers left Elk Mountain. The first diversion after resettlement was constructed on Mill Creek in 1879. Two ditches were dug, one on the north side and one on the south, to carry water to the land for irrigation.[45]

The day after the settlers arrived in Bluff in April 1880, they held a meeting to appoint two committees, one to divide the land and one to survey and dig a ditch.[89] The ditch committee started work the next morning. “They drove their picks and shovels through stratas of clay and quicksand with an assurance of reward which the San Juan and its valleys have never yet bestowed.” The most oft-heard cry that summer was, “The ditch is broken!” Upstream in Montezuma Creek, settlers had arrived a year earlier from Colorado. Along with a vanguard from the Bluff settlers, they diverted water onto the land to irrigate crops. Although the diversion works were built on rock, the river still took its toll when floods came.

5.3.1 Surface Water Supply

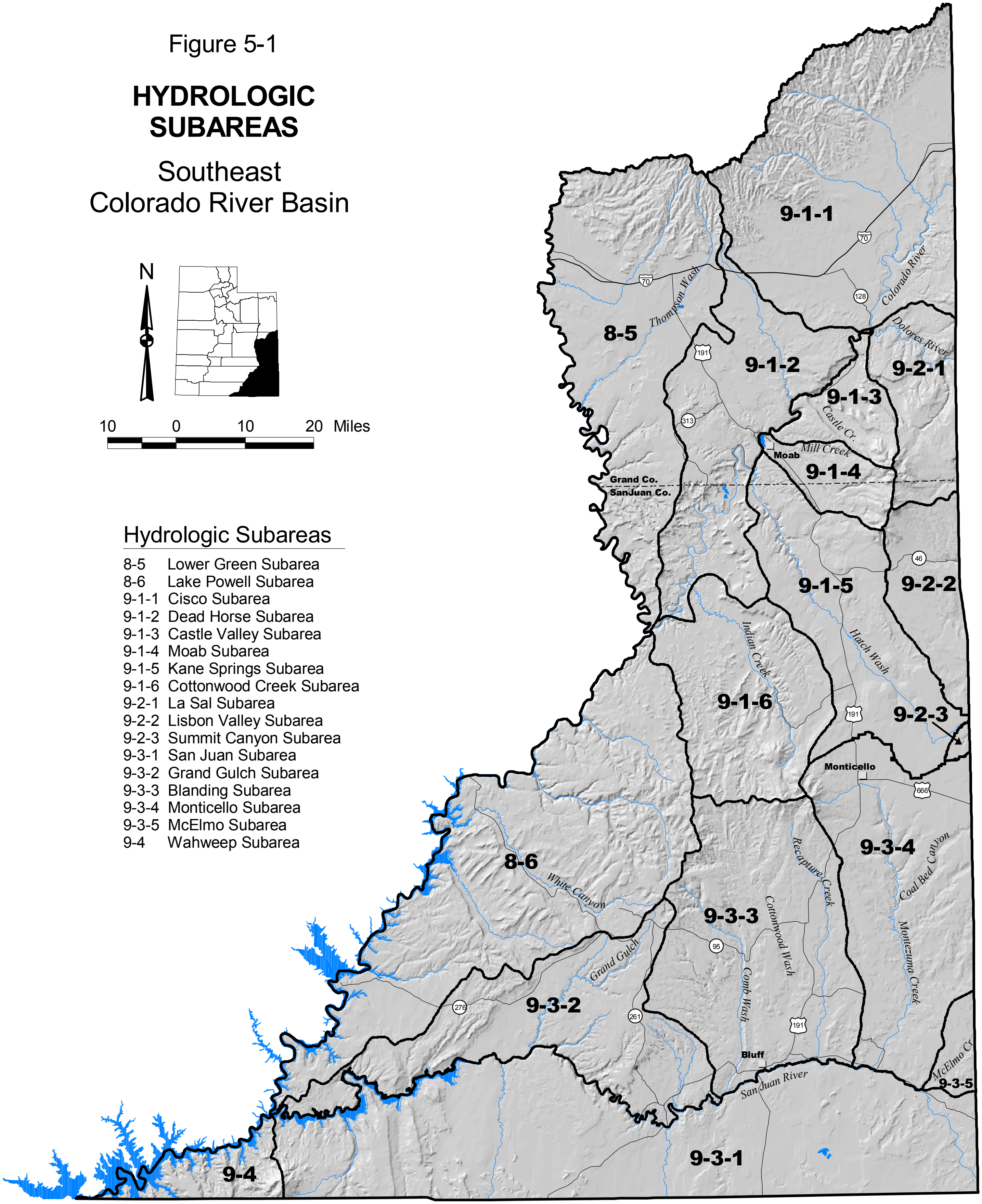
Most of the surface runoff comes from snow-melt during the months of April, May and June. Individual streams peak at different times depending on the watershed aspect, elevation and configuration. Runoff patterns are also influenced by watershed gradient, types of soils, and types and condition of vegetation.
Also, storage reservoirs modify surface water flows. Watersheds with good vegetative cover and sandy or clayey loam soils will retain water better and allow it to infiltrate down through the soil profile. This puts the moisture into the groundwater system so it reappears downslope later in the season than it would if it remained as surface water flows. The base flows of streams under these conditions are sustained longer into the season. The tributary water yield from each subarea is shown in Table 5-1.

Monticello Lake

Figure 5-1

HYDROLOGIC SUBAREAS

Southeast Colorado River Basin



Hydrologic Subareas

8-5	Lower Green Subarea
8-6	Lake Powell Subarea
9-1-1	Cisco Subarea
9-1-2	Dead Horse Subarea
9-1-3	Castle Valley Subarea
9-1-4	Moab Subarea
9-1-5	Kane Springs Subarea
9-1-6	Cottonwood Creek Subarea
9-2-1	La Sal Subarea
9-2-2	Lisbon Valley Subarea
9-2-3	Summit Canyon Subarea
9-3-1	San Juan Subarea
9-3-2	Grand Gulch Subarea
9-3-3	Blanding Subarea
9-3-4	Monticello Subarea
9-3-5	McElmo Subarea
9-4	Wahweep Subarea

Table 5-1 SUBAREA TRIBUTARY YIELD			
Subarea	Annual Yield (acre-feet)	Subarea	Annual Yield (acre-feet)
Cisco	12,460	Lisbon Valley	13,810
Dead Horse	10,420	San Juan	3,480
Castle Valley	9,800	Grand Gulch	7,060
Moab	22,030	Blanding	18,710
Kane Spring	12,170	Monticello	14,670
Cottonwood Creek	13,380	McElmo	980
La Sal	9,450	**Total**	**148,420**

Base Period: 1961-90
Yields were not calculated for the Lower Green, Lake Powell, Wahweep and Summit Canyon areas as there are no developed uses made of the small flows.

The amount of runoff or river flow is measured at stream gaging stations that have been or are currently operated and maintained by the U.S. Geological Survey. Some gages are operated on a cooperative basis with local entities or state agencies. Most of these stations are listed in Table 5-2 along with the period of record and average annual flows. The locations of these gaging stations are shown on Figure 5-2.

Most of the water supply comes from the portion of the La Sal and Abajo mountains above the 6,000 to 8,000-foot levels depending on aspect and location. These watersheds produce higher volumes of water and the flows last longer into the summer.

Runoff produced below about 7,000 feet in elevation is erratic in some areas as most of it comes from summer thunderstorms producing cloud-burst flood flows. These flows have high peaks but are of short duration and low volume, often with loads of sediment and debris. Only a small part of this type of flow can be controlled and utilized.

Mill Creek

Yield from the La Sal Mountains supplies the Moab, Castle Valley and La Sal areas and yield from the Abajo Mountains supplies the Monticello and Blanding areas. The schematic representations of average annual flows for three streams are shown in Figures 5-3, 5-4 and 5-5. The width of the arrows and bands indicates the average annual flow volume. The flow volumes are derived or estimated from stream gage data or other records and by correlation.

Table 5-2
Gaging Station Record - Southeast Colorado River Basin [66]
(acre-feet)

Number	Stream Gage Name	Years	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Ann
09169000	Two Mile near La Sal	1945-1951	27	27	28	29	30	67	624	626	86	26	21	21	1,612
09177500	Taylor Creek near Gateway, Co.	1945-1967	26	29	29	24	31	103	1,038	715	211	40	36	16	2,298
09178000	Deep Creek near Paradox, Co.	1945-1953	36	74	85	80	70	94	212	258	255	100	19	21	1,304
09178500	Geyser Creek near Paradox, Co.	1945-1951	0	0	0	0	0	0	19	69	118	0	0	0	206
09180000	Dolores River near Cisco	1951-1998	13,984	12,011	11,310	10,801	12,603	25,971	125,404	195,894	122,950	40,544	18,969	13,384	603,825
09180500	Colorado River near Cisco	1914-1998	243,959	227,104	203,105	189,780	182,719	238,378	497,076	12,154,615	1,399,441	573,259	268,738	219,902	16,398,076
09180920	Onion Creek above Onion Creek Bridge near Moab	1980-1981	75	83	86	94	87	87	79	89	69	63	80	55	947
09180970	Onion Creek below Onion Creek Bridge near Moab	1980-1981	58	71	71	83	140	376	136	105	68	53	76	51	1,288
09181000	Onion Creek near Moab	1951-1955	44	64	62	56	66	174	60	60	31	33	140	38	828
09181500	Professor Creek near Moab	1951-1953	152	220	164	201	212	157	162	13	16	19	186	25	1,527
09182000	Castle Creek above Diversions, near Moab	1951-1975	34	29	24	20	17	21	38	181	245	129	62	40	840
09182200	Castle Creek below Castleton near Moab	1993-1998	162	144	148	149	138	157	146	400	479	320	187	167	2,597
09182400	Castle Creek below Castle Valley near Moab	1993-1998	445	487	470	469	410	464	407	475	496	365	316	348	5,152
09182500	Castle Creek near Moab	1951-1958	279	464	464	486	468	510	324	148	72	29	382	176	3,802
09182900	Courthouse Wash at Arches Hwy Cross near Moab	1959-1965	38	2	6	80	87	19	42	15	5	229	238	326	1,087
09183000	Courthouse Wash near Moab	1950-55, 67-98	185	65	45	50	43	92	99	77	133	122	228	131	1,270
09183500	Mill Creek at Sheley Tunnel, near Moab	1955-59, 88-98	533	448	419	385	329	402	674	1,816	1,739	942	626	529	8,842
09184000	Mill Creek near Moab	1950-71, 73-93	623	566	539	494	475	523	795	1,802	1,696	930	819	663	9,925
09184500	Pack Creek at M4 Ranch, near Moab	1955-1959	55	51	47	44	46	54	82	476	665	187	79	54	1,840
09185000	Pack Creek near Moab	1955-1959	201	206	231	240	244	258	224	427	513	129	126	114	2,913
09185500	Hatch Wash near La Sal	1951-1971	64	6	6	5	38	468	84	8	3	74	338	63	1,157
09185800	Indian Creek Tunnel near Monticello	1958-59, 61-80	48	34	20	16	16	26	79	287	347	136	56	38	1,103
09186000	Indian Creek near Monticello	1950-1957	38	27	22	19	20	30	214	816	690	118	66	30	2,090
09186500	Indian Creek above Cottonwood Creek, near Monticello	1950-71, 89-91	87	80	62	51	44	75	382	1,060	730	145	129	74	2,919
09187000	Cottonwood Creek near Monticello	1950-1957	100	121	123	162	172	178	357	337	276	142	227	49	2,244
09187500	Indian Creek above Harts Draw, near Monticello	1950-1957	229	90	153	200	238	136	465	805	992	394	545	96	4,343
09187550	Indian Creek above Bogus Pocket, near Monticello	1984-1987	496	489	321	460	474	717	1,828	3,008	1,254	478	748	213	10,486
09372200	McElmo Creek near Bluff	1981-1982	2,878	2,430	2,907	2,744	5,695	4,978	4,364	5,089	6,831	5,397	8,137	6,725	58,175
09376900	Spring Creek above Diversion, near Monticello	1966-1972	12	7	3	2	1	24	90	307	240	27	20	5	738
09378100	North Creek above Ranger Stat near Monticello	1980-1985	11	10	7	6	5	14	181	502	598	57	0	0	1,391
09378170	South Creek above Reservoir near Monticello	1986-1998	14	39	12	11	18	146	399	497	199	43	18	17	1,413
09378200	Montezuma Creek at Golf Course at Monticello	1980-1992	22	36	16	16	22	126	709	977	533	74	17	13	2,561
09378600	Montezuma Creek near Bluff	1986-1993	254	643	210	963	1,889	4,738	2,272	1,047	486	185	289	212	13,188
09378630	Recapture Creek near Blanding	1966-1998	11	8	3	2	7	106	297	411	139	10	4	1	999
09378650	Recapture Creek below Johnson Creek near Blanding	1976-1993	25	60	3	5	77	644	2,090	2,331	911	90	14	10	6,260
09378700	Cottonwood Wash near Blanding	1965-1987	434	151	202	163	468	900	1,551	1,085	227	277	816	228	6,502
09379000	Comb Wash near Bluff	1959-1968	57	45	188	0	3	30	25	5	86	325	945	330	2,039
09379500	San Juan River near Bluff	1915-1998	100,273	72,714	66.512	67,070	82,115	117,683	213,730	355,171	364,174	166,932	113,425	99,163	1,818,962

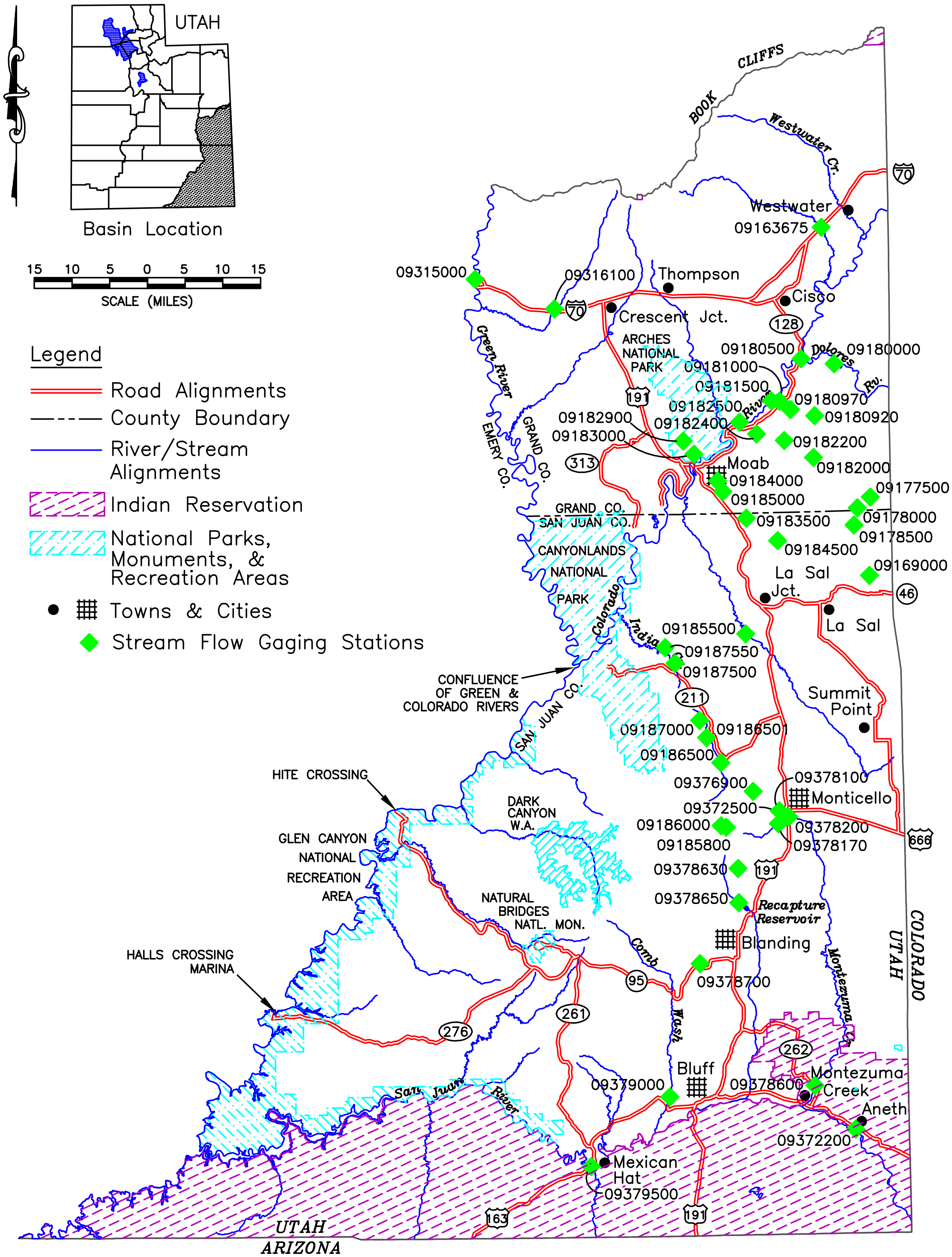


Figure 5–2
STREAM FLOW GAGING STATIONS
Southeast Colorado River Basin

Figure 5–3
MOAB AREA STREAM FLOW SCHEMATIC
Southeast Colorado River Basin

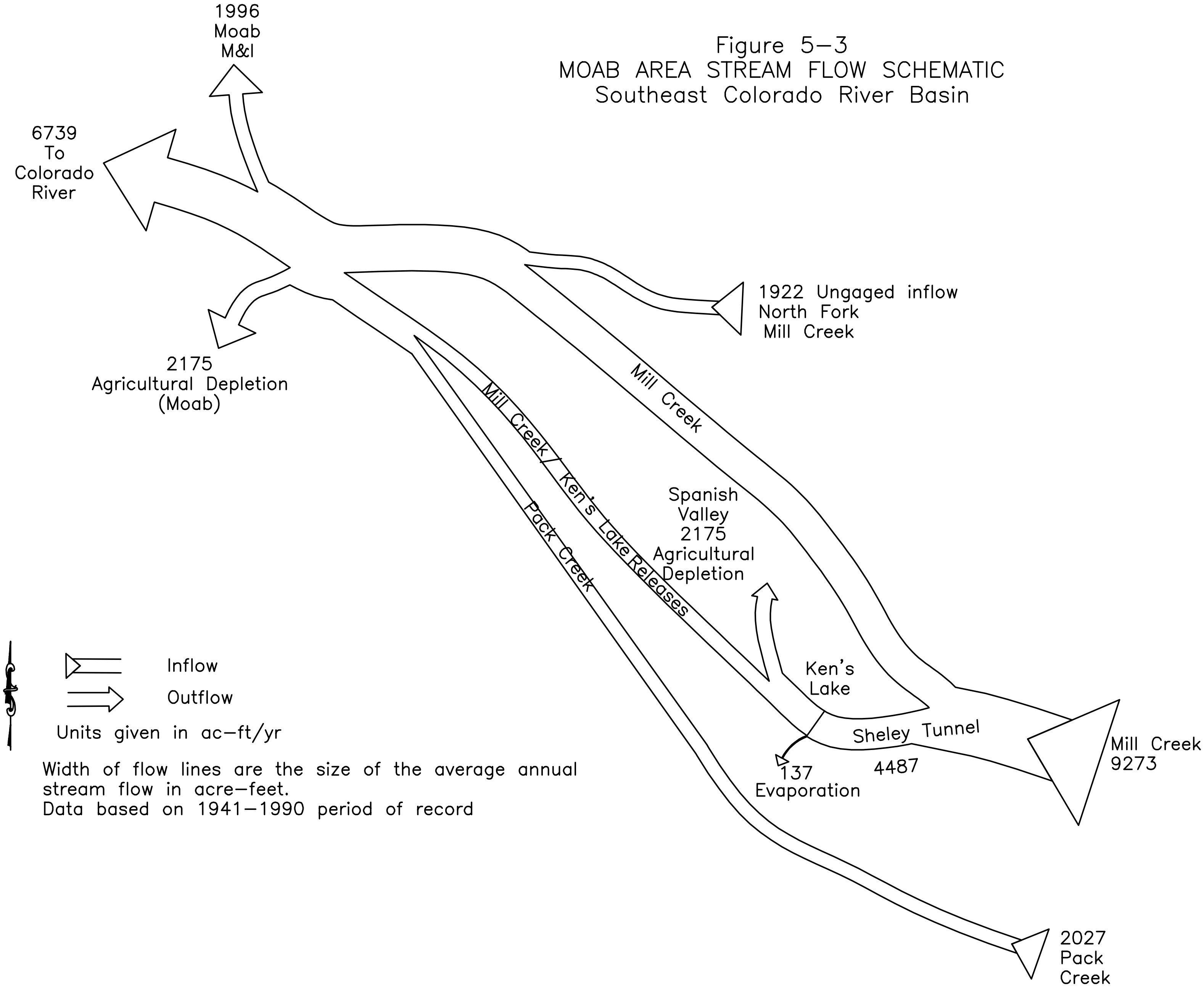
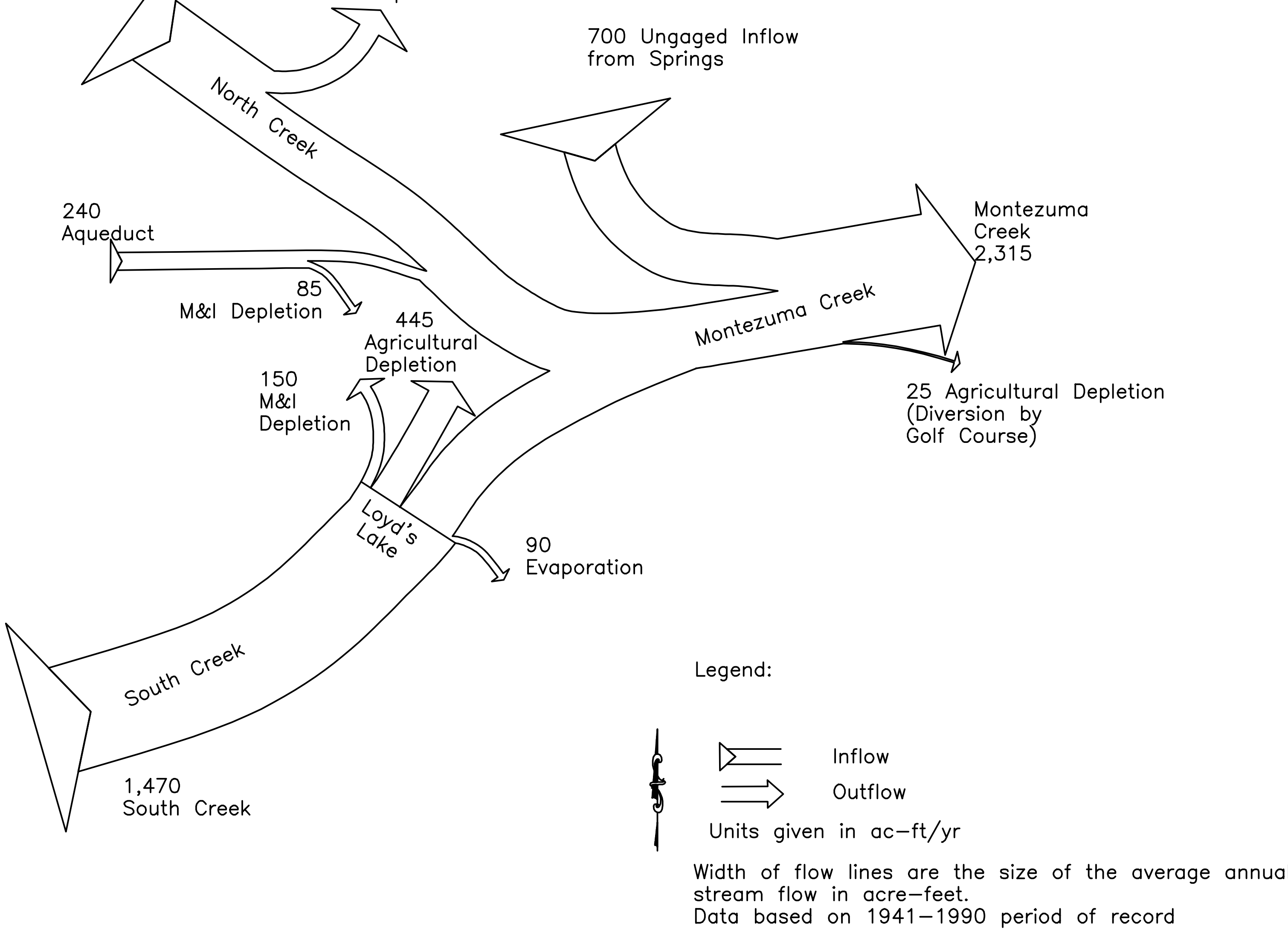


Figure 5–4
MONTICELLO AREA STREAM FLOW SCHEMATIC
Southeast Colorado River Basin



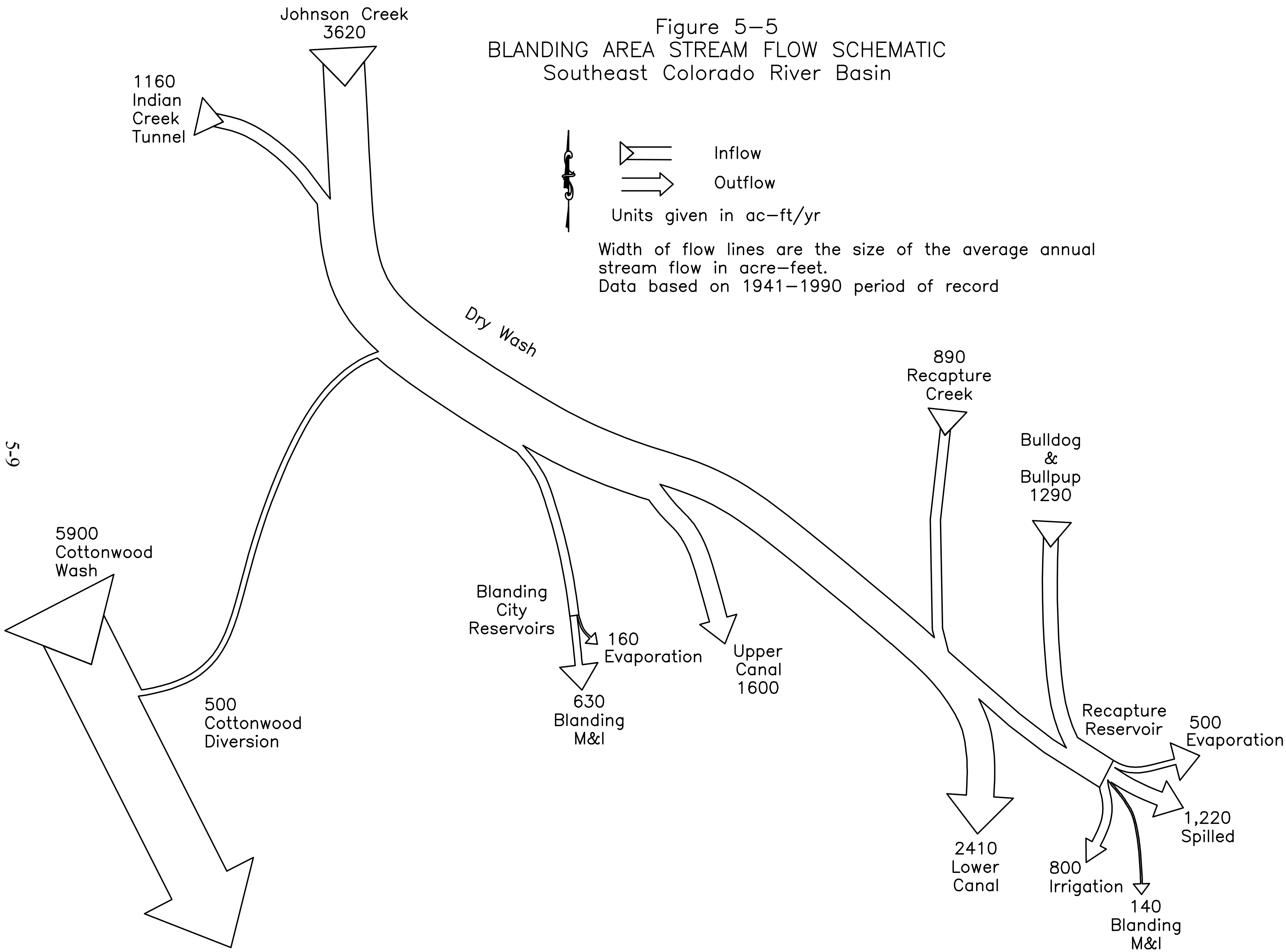


Figure 5–5
BLANDING AREA STREAM FLOW SCHEMATIC
Southeast Colorado River Basin

The average annual flows for four locations are shown graphically. These are: Mill Creek near Moab, Figure 5-6; South Creek above Reservoir near Monticello (Loyd's Lake), Figure 5-7; Recapture Creek near Blanding, Figure 5-8; and Montezuma Creek near Bluff, Figure 5-9. The general shape of the hydrographs for different probabilities are shown for Mill Creek near Moab on Figure 5-10 and for Recapture Creek near Blanding on Figure 5-11.

5.3.2 Groundwater Supply

Groundwater has been withdrawn over the past century from two types of aquifers, consolided rock and unconsolidated or alluvial deposits. The water-yielding consolidated rock units cover most of the basin at varying depths. The alluvial aquifers are limited in extent and use with the exception of Spanish Valley in Grand and San Juan counties and Castle Valley in Grand County.

The Spanish Valley aquifer is a major source of culinary water for residents in the Moab area. The most productive wells are generally just above Moab where the aquifer discharges to the Colorado River. Measured well production has been as high as 2,500 gpm within the Moab well fields with some individual local springs producing over 300 gpm.

All of the culinary water in the Moab, Spanish Valley and Castle Valley areas is derived from local groundwater sources, about 80 percent from wells and 20 percent from springs. The valley aquifers consist of unconsolidated, coarse alluvial-fan deposits and stream alluvium with minor deposits of clay. However, underlying consolidated rock aquifers contribute to the overall aquifer production.

A substantial amount of well pumpage can be attributed to underflow from existing consolidated rock formations fed from Castle and Placer creeks. The Division of Water Rights, in cooperation with the Town of Castle Valley, has just completed a groundwater study in the area to determine the potential capacity of the groundwater acquifers and identify any water quality problems in these water sources.[29]

Many of the springs in the basin have low yields but are generally of good water quality. Data on springs producing over 20 gallons per minute (32.3 acre-feet/year) are shown in Table 5-3. One spring on the Navajo Indian Reservation flowing 10 gallons per minute is shown as typical of that area.

Most of the public and domestic culinary water supplies come from groundwater, primarily from wells. The present supply of groundwater available is limited by water rights, hydrologic constraints and/or system constraints. These groundwater supplies are shown in Table 5-4.

Groundwater seep for livestock water

5.4 WATER USE

Water use is closely related to the basin’s current economic base. The primary use of water is for agriculture while other uses include residential, municipal, commercial and industrial purposes.

5.4.1 Municipal and Industrial Water Use

Municipal and Industrial (M&I) water use includes all diversions for residential developments, commercial businesses, industrial plants and operations, public buildings, and institutional uses and related outdoor facilities. M&I water is classified as treated (culinary or potable) or untreated (secondary or nonpotable).

Municipal Water Use - Culinary water is generally provided by public works departments of local municipalities and by larger water

Figure 5-6

ANNUAL FLOWS

Mill Creek near Moab

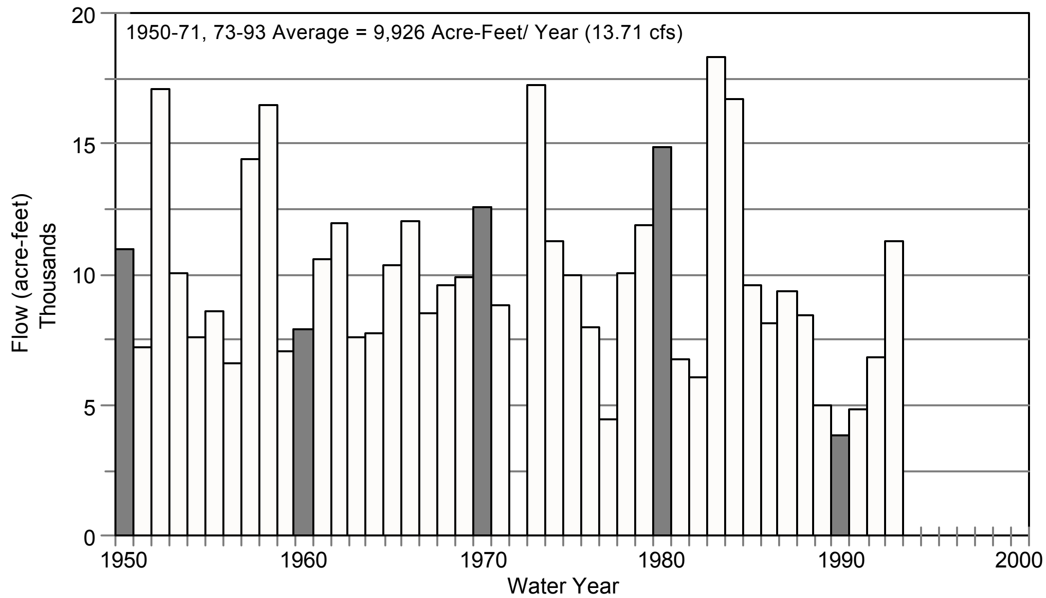


Figure 5-7

ANNUAL FLOWS

South Creek above Reservoir near Monticello (Loyd's Lake)

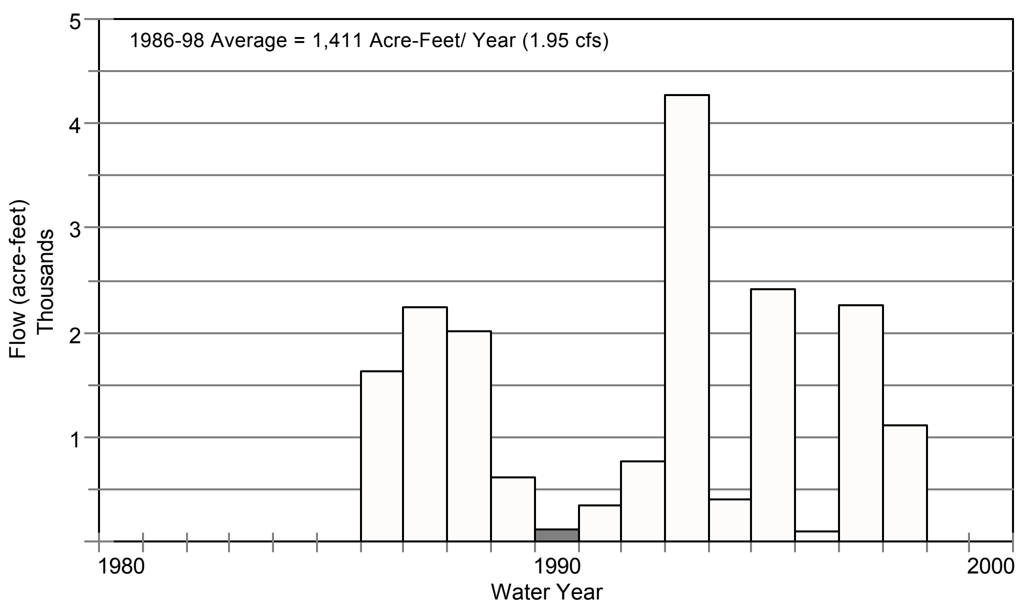


Figure 5-8

ANNUAL FLOWS

Recapture Creek near Blanding

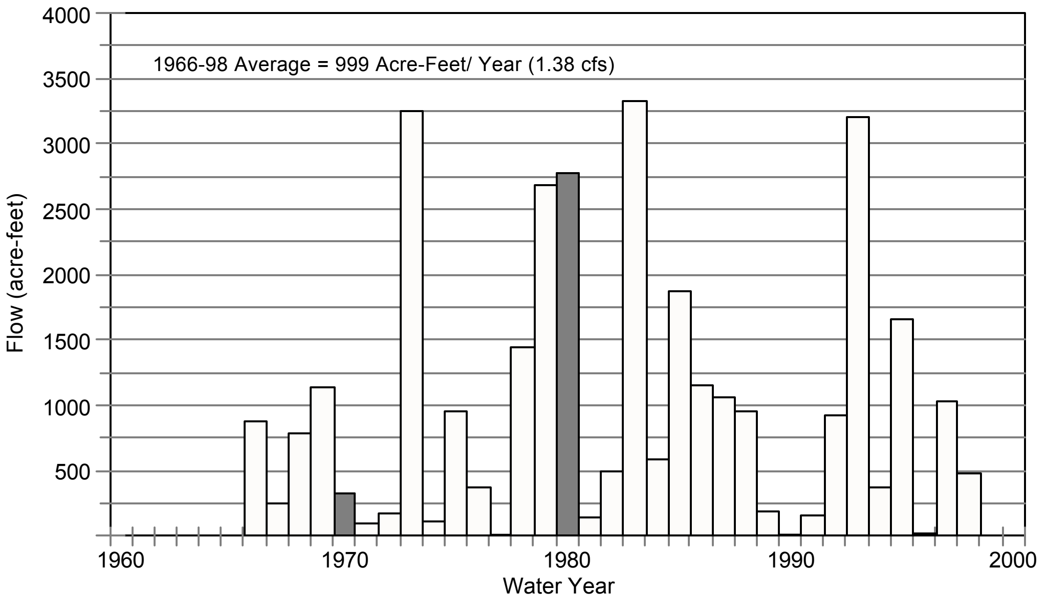


Figure 5-9

ANNUAL FLOWS

Montezuma Creek near Bluff

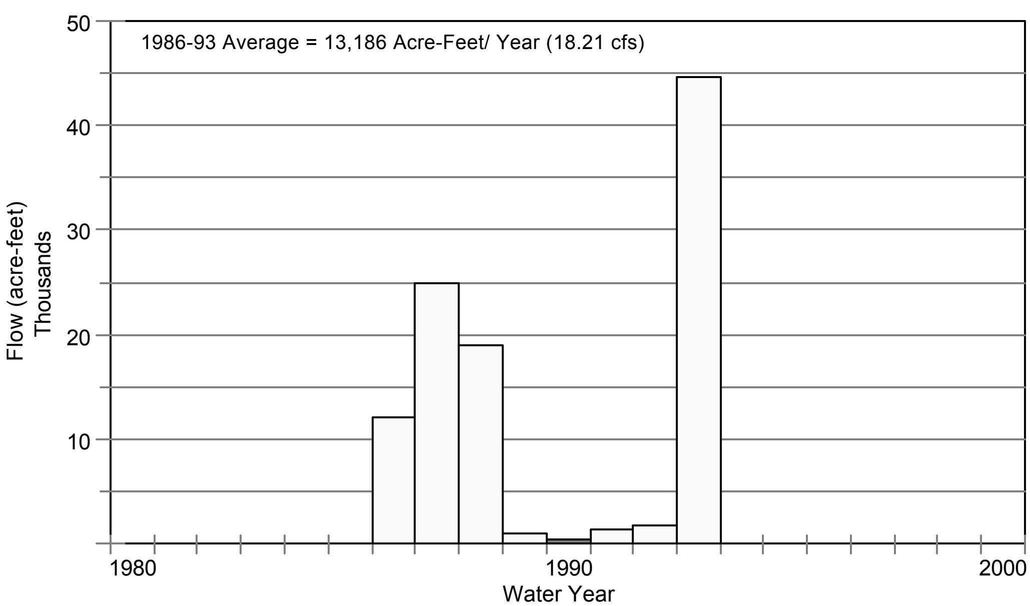


Figure 5-10

MONTHLY STREAMFLOW PROBABILITES

Mill Creek near Moab

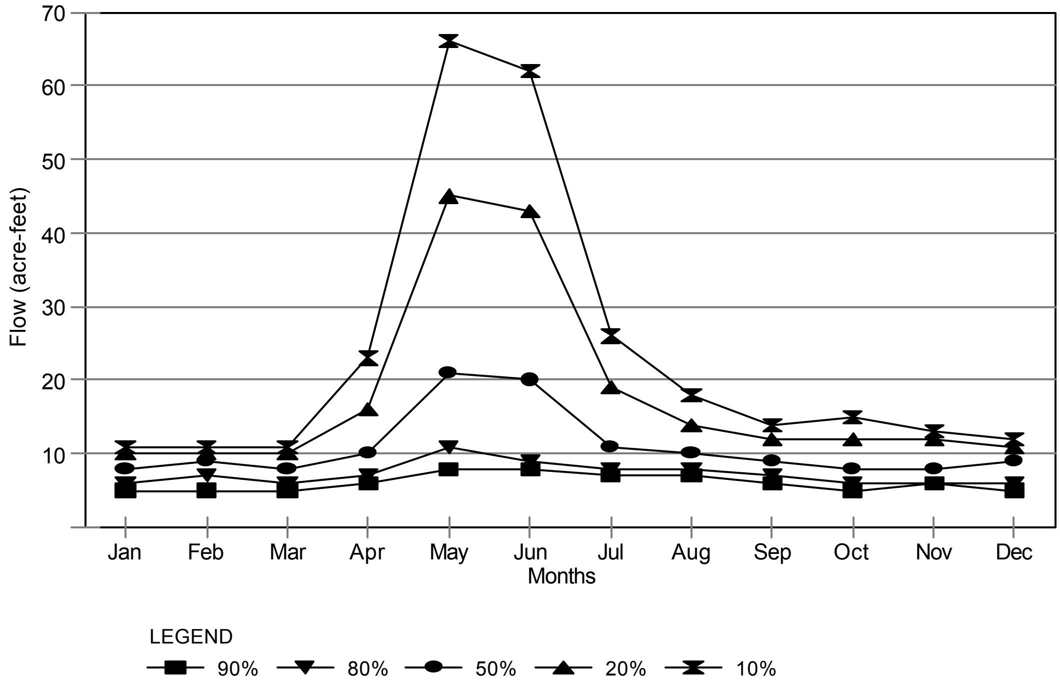


Figure 5-11

MONTHLY STREAMFLOW PROBABILITES

Recapture Creek near Blanding

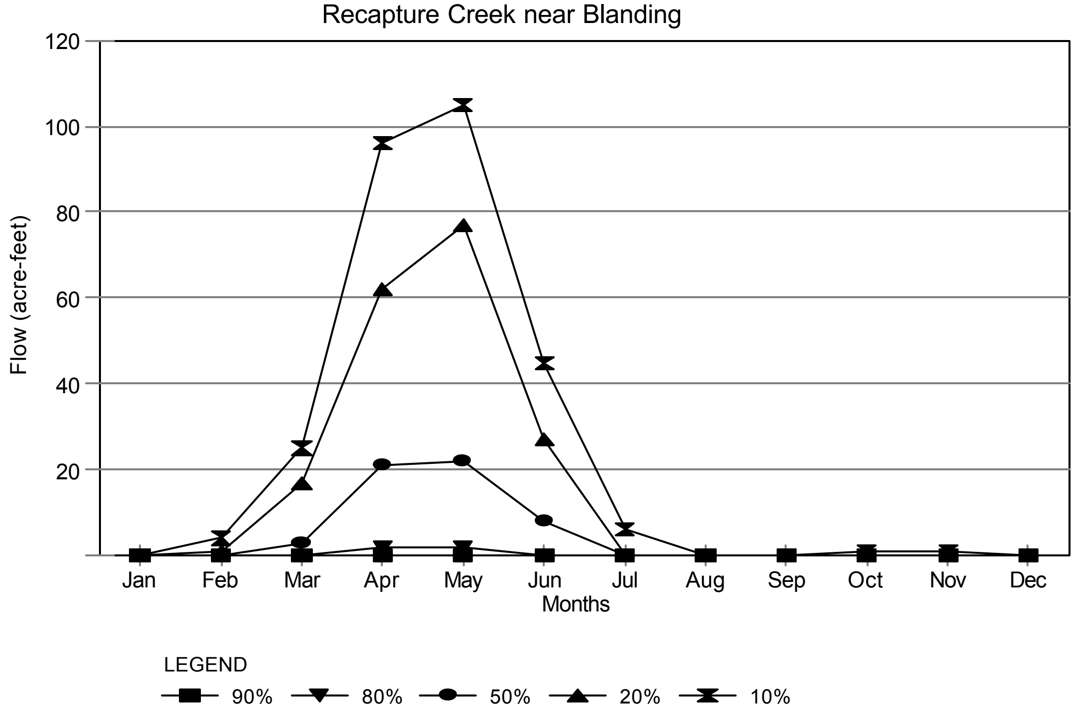


Table 5-3
SELECTED SPRINGS[21,23]

Spring	Location (T,R,Sec)	Discharge (gal/min)	Quality (µS/cm)	Date
Kane	21,24,36	43.5	5,290	9-8-85
Burn	22,25,12	42.0	680	9-7-85
Unnamed seep	22,25,18	20.0	1,100	9-8-85
Skakel	25,21,35	240 450	290 -	8-15-85 9-23-91
Watercress	25,21,35	198		9-23-91
Jackson Res	26,22,07	24	954[a]	3-68
Deep Cut	26,22,14	90.0	305	11-19-68
Birch	26,22,15	90.0	295	10-19-67
Somerville	26,22,15	15.0	350	11-6-86
Moab #1	26,22,15	50.0	460	8-16-85
Moab #2	26,22,22	330	280	8-16-85
Moab #3	26,22,22	390	285	8-15-85
Warner Lake	26,24,28	200	170[a]	7-67
Pack Creek	27,23,24	200	1,220[a]	4-68
Barber	27,24,30	30	1,240[a]	4-68
Coyote	28,24,14	112	220	-64
9Y21 (NN)	43,20,23	10		

Note: Only springs with flows greater than 20 gallons per minute are shown except the typical 9Y21 used by the Navajo Nation (NN). Water quality specific conductance is measured in µS/cm. See Appendix A for definitions.

[a] Values are in micromhos per centimeter.

Table 5-4
POTABLE GROUNDWATER SYSTEM SOURCE SUPPLIES[14,15,84]

Type of Use	Springs (ac-ft)	Wells (ac-ft)	Total (ac-ft)
GRAND COUNTY			
Public Community Systems	1,870	8,140	10,010
Public Non-Community Systems	0	40	40
Private Domestic Use	0	890	890
Grand County Total	**1,870**	**9,070**	**10,940**
SAN JUAN COUNTY			
Public Community Systems	870	410	1,280
Public Non-Community Systems	neg.	20	20
Private Domestic Use	0	600	600
Navajo Tribal Utility Auth	0	1,800	1,800
Other Navajo Indian Comm Systems	30	320	350
San Juan County Total	**900**	**3,150**	**4,050**
BASIN TOTAL	**2,770**	**12,220**	**14,990**

Note: The public community systems data are the available supply. Section 11 shows the current use. The above data does not include self-supplied industrial water, irrigation water or livestock water from wells or springs.
Source: M&I Water Supply Studies by the Division of Water Resources and Navajo Tribal Utility Authority data. One self-supplied industrial well supplies about 1,000 acre-feet. In addition, over 2,000 acre-feet are discharged from springs used for purposes other than culinary water.

conservation districts that retail water to customers or wholesale water to other provider agencies, municipalities or commercial businesses. In addition, 1,490 acre-feet are provided by private domestic systems. Recent statewide studies by the Division of Water Resources on residential water use show about 35 percent is used inside the home and 65 percent is used for outside purposes.

The major providers of culinary water include three municipalities, five water districts, one school district and a number of publicly and privately owned small community systems. In addition there are 16 community systems providing culinary water on the Navajo Indian Reservation and one community system operated by the Ute Mountain Utes at White Mesa.

One notable diversion is 1,160 acre-feet of water (1941-90 average) from upper Indian Creek into Johnson Creek to supplement municipal and irrigation water supplies in Blanding. This water is diverted through a tunnel completed in 1952. A measurement made on June 19, 1979 showed a flow of 45 cfs. Diversion of the maximum flow only occurs for a short time during peak runoff periods during May, June and July. A summary of annual diversions for both culinary and secondary water is given in Table 5-5.

Halchita culinary water tanks

Data for Table 5-5

CULINARY AND SECONDARY WATER DIVERSIONS - 1996

System	Residential	Commercial	Institutional	Industrial	Total
		(acre-feet)			
GRAND COUNTY	**CULINARY WATER DIVERSIONS**				
Public Community Systems	1,551	445	167	0	**2,163**
Non-Community Systems	895[a]	18	14	0	**927**
Grand County Total	**2,446**	**463**	**181**	**0**	**3,090**
SAN JUAN COUNTY					
Public Community Systems	1,071	167	131	4	**1,373**
Non-Community Systems	657[b]	92	25	0	**774**
San Juan County Subtotal	**1,728**	**259**	**156**	**4**	**2,147**
NTUA[c] Public Systems	95	15	39	26	**175**
Other Navajo Indian Systems	144	0	12	0	**156**
Navajo Indian Reservation Subtotal	**239**	**15**	**51**	**26**	**331**
San Juan County Total	**1,967**	**274**	**207**	**30**	**2,478**
BASIN TOTAL	**4,413**	**737**	**388**	**30**	**5,568**
	SECONDARY WATER DIVERSIONS - 1996				
GRAND COUNTY					
Public Community Systems	124	0	580	0	**704**
Non-Community Systems	0	0	0	940[d]	**940**
Grand County Total	**124**	**0**	**580**	**940**	**1,644**
SAN JUAN COUNTY					
Public Community Systems	262	0	0	0	**262**
Non-Community Systems	3	0	8	1,090[d]	**1,101**
San Juan County Total	**265**	**0**	**8**	**1,090**	**1,363**
BASIN TOTAL	**389**	**0**	**588**	**2,030**	**3,007**

Source: Municipal and Industrial Water Supply Studies by the Division of Water Resources and from Navajo Tribal Utility Authority data.

a Includes 890 acre-feet of private domestic use

b Includes 600 acre-feet of private domestic use

c NTUA: Navajo Tribal Utility Authority.

d Self-supplied industrial water.

Industrial Water Use - The processing of precious metals, oil, natural gas, uranium, salt and other minerals often requires substantial quantities of water. The annual demand for industrial water varies considerably depending on the type and production capacity of each individual processing plant. It also depends on the current market for the product being processed. Due to the fluctuation in the demand for some minerals (uranium being the most prominent), it is not unusual for major processing plants to cut back on production or shut down completely. Data for water use by industries are not always available due to the proprietary nature of the industry. The self-supplied industrial water use reported for 1996 was 2,030 acre-feet or less than one-fourth of the total M&I diversions.

5.4.2 Agricultural Water Use

Water development has been occurring since the area was settled with irrigated agriculture as an important element of the local economy. A number of large irrigation projects have been built recently to supply the increased agricultural water demand. These projects include Mill Creek (Ken's Lake) Reservoir, Monticello (Loyd's Lake) Reservoir and Recapture Creek Reservoir along with related diversions, pipelines, canals and other management structures. These were completed primarily for supplemental irrigation water although municipal and industrial needs are an important part of the projects. The average annual quantity of water diverted for cropland irrigation is 34,950 acre-feet of which 18,430 acre-feet are depleted.

In the Cisco Subbasin, 75-80 percent of the cropland is irrigated with an estimated 5,060 acre-feet of water pumped from the Colorado River. There is 1,580 acre-feet of water pumped from the Colorado River for irrigation in the Castle Valley area. About 2,000 acre-feet of water is diverted from the Dolores River into the Kane Spring Subbasin for irrigation and stockwater and over 1,000 acre-feet is diverted from the San Juan River. Other areas are irrigated primarily with water diverted from local streams.

The irrigated acreage along with diversions and depletions of water used for agriculture are summarized in Table 5-6. See Section 10 for more information.

Sprinkler on Spanish Valley

5.4.3 Wetlands and Open Water Areas

Wetlands and open water areas include those with vegetation using large amounts of water through evapotranspiration by plants and/or evaporation from water surfaces. The net evaporation from reservoirs in the water-budget areas is 2,050 acre-feet.

Table 5-6
IRRIGATION WATER USE BY COUNTY

County	Area (acres)	Average Annual Diversions (acre-feet)	Water Use Depletions (acre-feet)
Grand	2,780	13,800	6,910
San Juan	6,150	21,150	11,520
Total	**8,930**	**34,950**	**18,430**

Most of the wetland areas are found along the rivers and streams. They also occur near springs, reservoirs, bogs, wet meadows, lakes and ponds. Wetlands and riparian vegetation are varied and support a wide diversity of wildlife species. Only the wetlands and open water areas in and near the irrigated areas were mapped with data included in this report. Wetlands and open water areas at higher elevations were not mapped as part of this study.

5.4.4 Instream Flow Requirements

The basin's river systems are diverse. They range from one of the largest river drainages in the United States (Colorado River) to small high mountain streams. The larger river systems; the Colorado, Green, Dolores and San Juan rivers, provide year-round instream flows for recreation and fish habitat. Many of the smaller streams are intermittent except in the upper reaches, and have no storage, making them less suitable as fisheries. The only required instream flow is a minimum of three cubic feet per second in Mill Creek below the Sheley Tunnel diversion to the valley proper. There is no minimum flow requirement in this stream below the Moab Irrigation Company diversion. See Section 14 for more information on fisheries and riparian habitat.

5.4.5 Recreation

Outdoor water-related recreation includes river running, kayaking, swimming, boating and fishing. Not so obvious, but perhaps of equal enjoyment, are activities such as hiking along existing streams and rivers, camping near reservoirs and streams, or simply taking a sightseeing trip through the high mountains, a forest or a canyon with water amenities along the way.

Recreation is an acknowledged and viable use of the basin's water resources. The initial planning and justification of most water development projects includes provisions for recreation. Federal and state agencies spend considerable amounts of money to assure that outdoor recreational opportunities are maintained and managed at reservoirs, rivers and streams. Other recreational water-use includes conservation pools in reservoirs for the maintenance of fish habitat, swimming and boating. Water is also provided for culinary uses at local, state and federal campgrounds and other recreational facilities.

Hite Marina

The water provided for recreation is not consumed. Water-based recreation is included as a benefit in most projects; however, quantification of this type benefit is difficult. Local, state and federal agencies fund facilities to assure the public access to meaningful and satisfying recreation. ❑